
# Overview of CLARREO IR Calibration Demonstration System (CDS)

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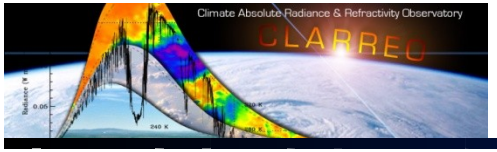
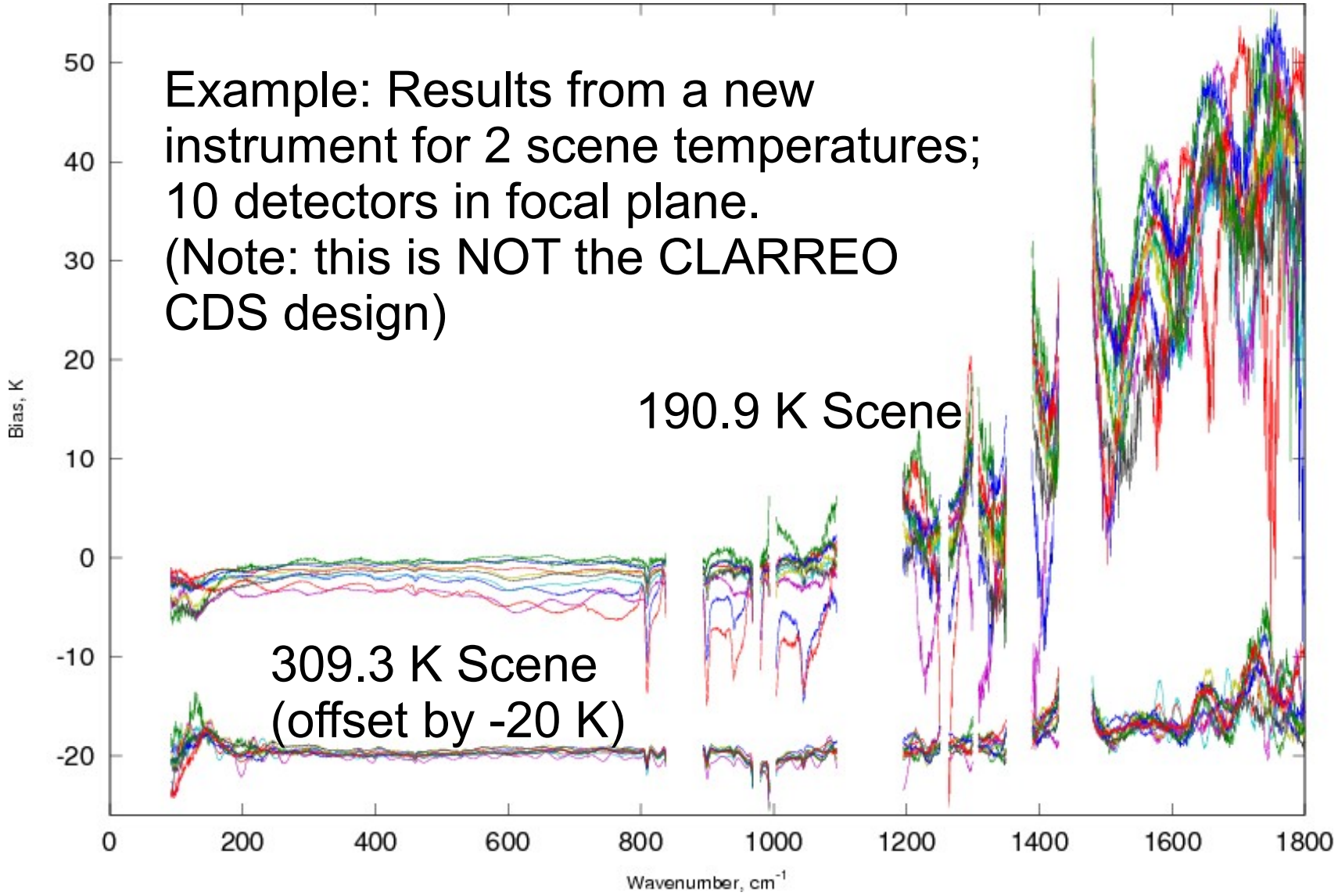
# CDS Goal and Requirements

- Goal:
  - Learn how to measure brightness temperature to 0.1 K (k=3) for scene temperatures of 200-320 K from 200 to 2000 $cm^{-1}$ .
- General Design Requirements:
  - Design spectrometer and calibration sources with sufficient diagnostic sensors and operational flexibility to diagnose sources of bias.
  - Include observations of a variable temperature blackbody source to quantify measurement bias over a range of scene temperatures.
- In addition:
  - Use flexible system architecture to enable easy addition of improvements that result from lessons learned.



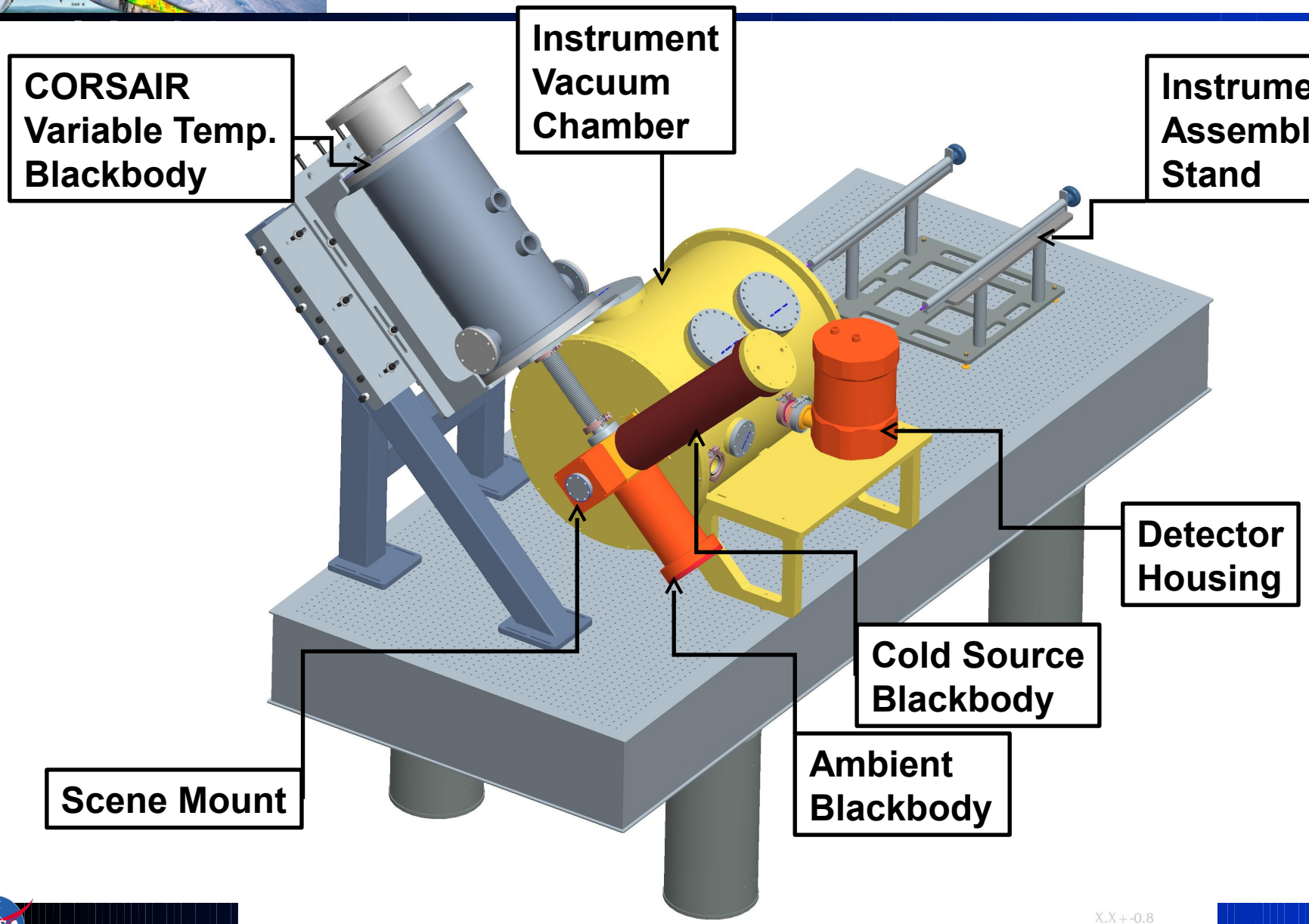

# Initial results are often puzzling:



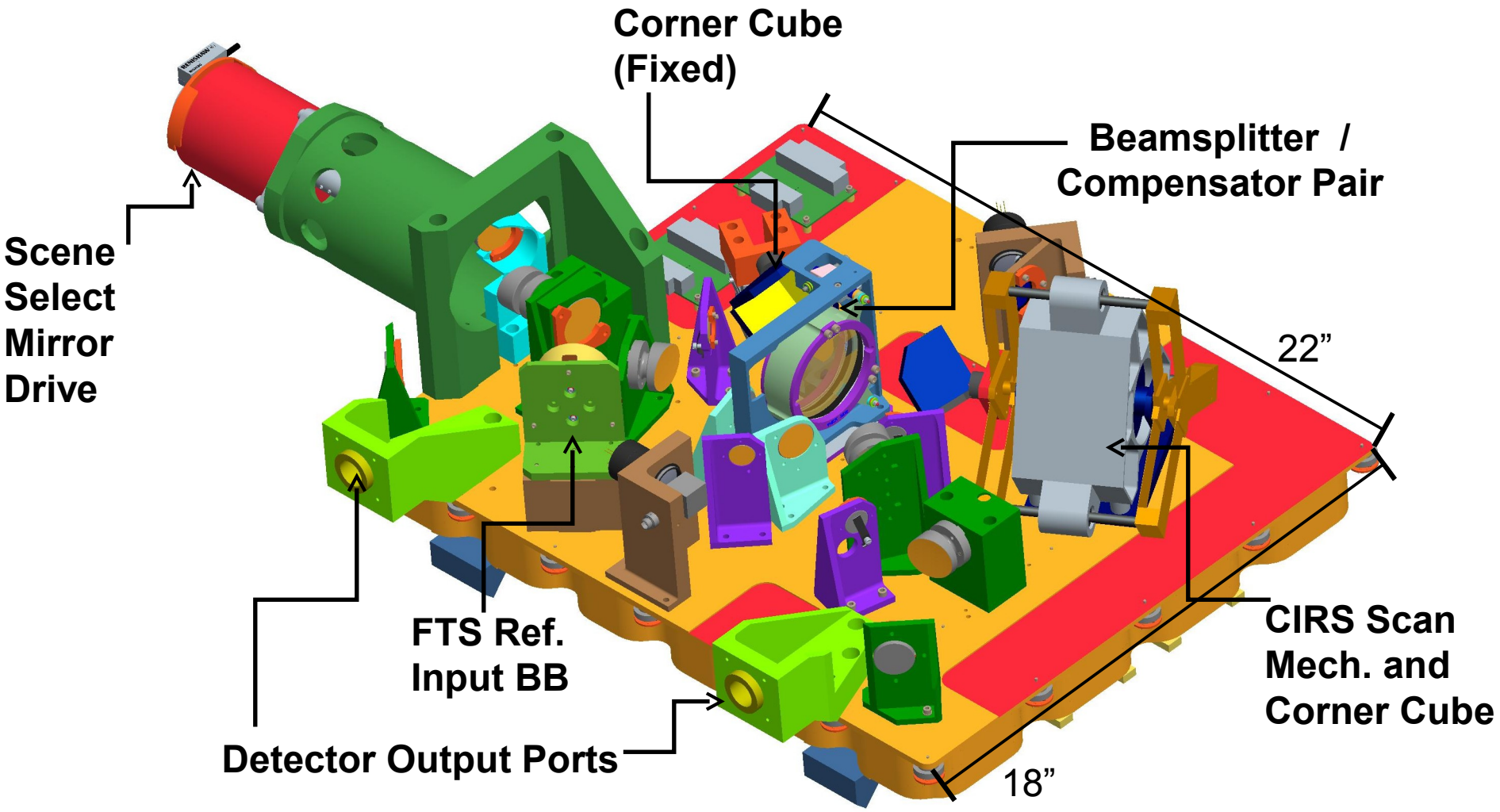

# Key CDS design features

- 4-port Fourier transform spectrometer (FTS; 2 inputs, 2 outputs).
- Input pupil at calibration blackbody aperture, intermediate pupil at FTS cube corner, exit pupil at FTS output.
- FTS operated in vacuum housing for thermal and acoustic isolation, elimination of atmospheric absorption, and protection of hygroscopic CsI beamsplitter.
- Use fold mirror and stepper motor to switch between ambient and $LN_2$-cooled blackbody calibration sources and test source.
- No windows on FTS input.

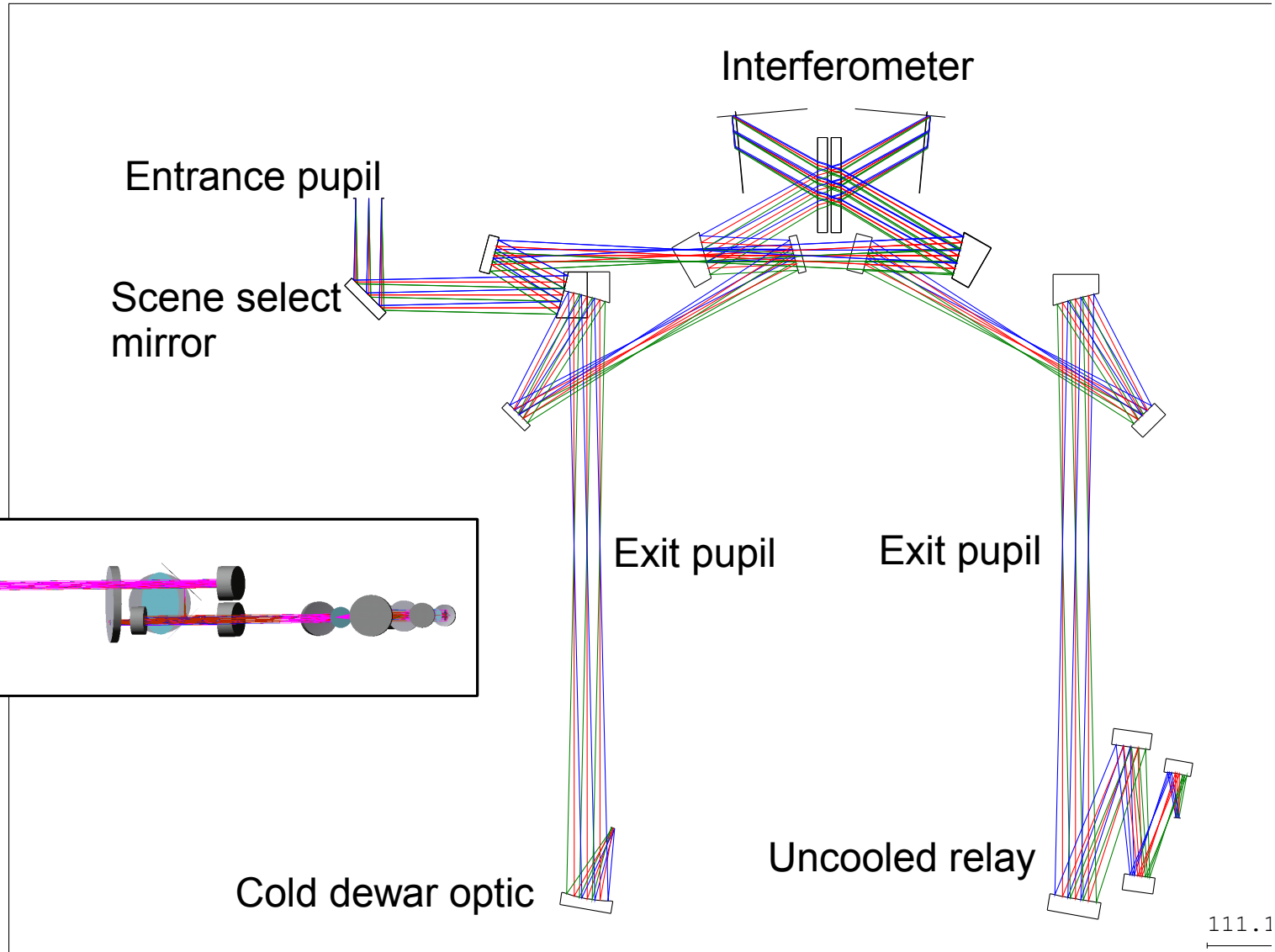
# Instrument Overview



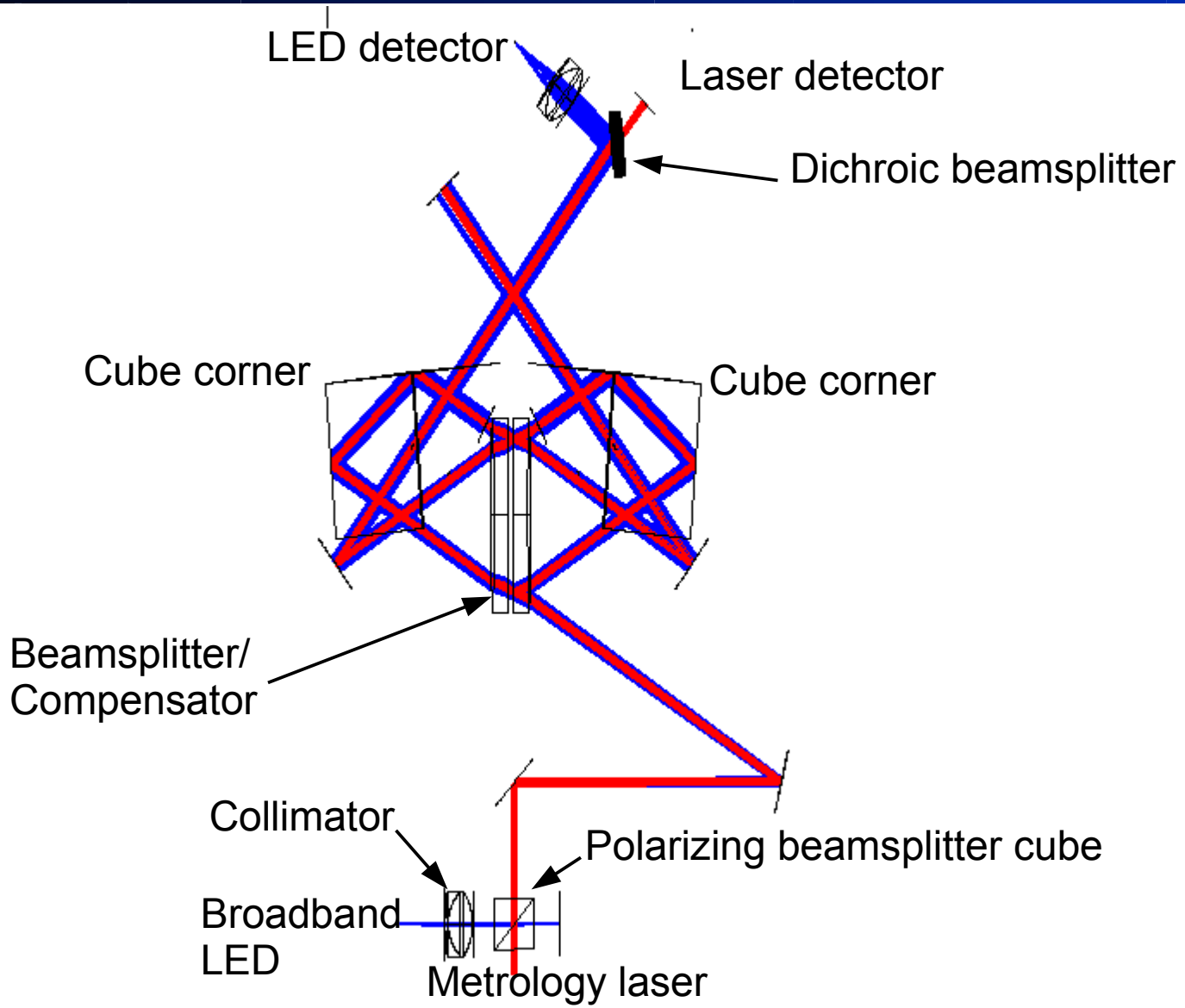
# Optical Bench



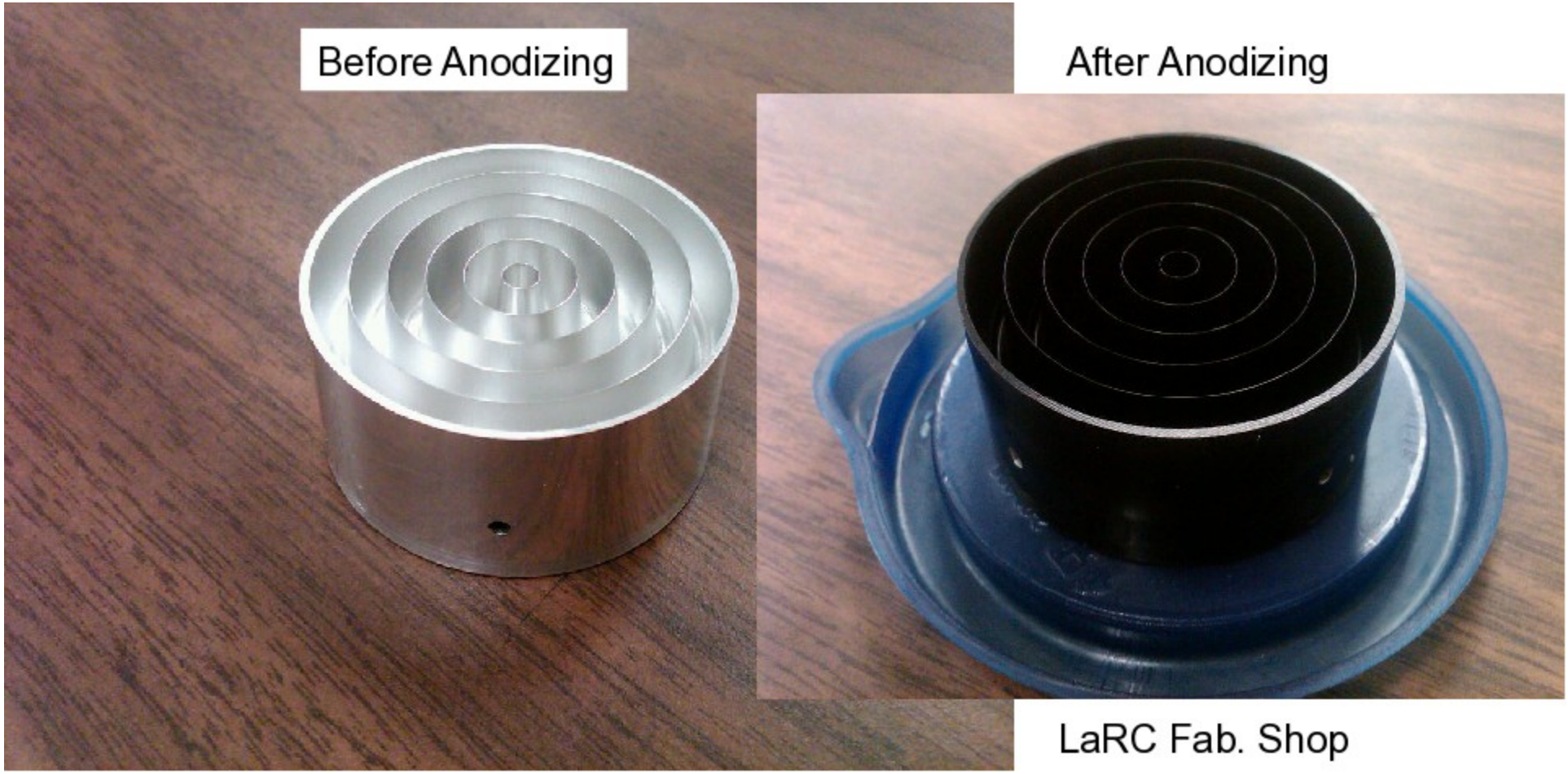

# Optical layout: Science



# Optical layout: Metrology

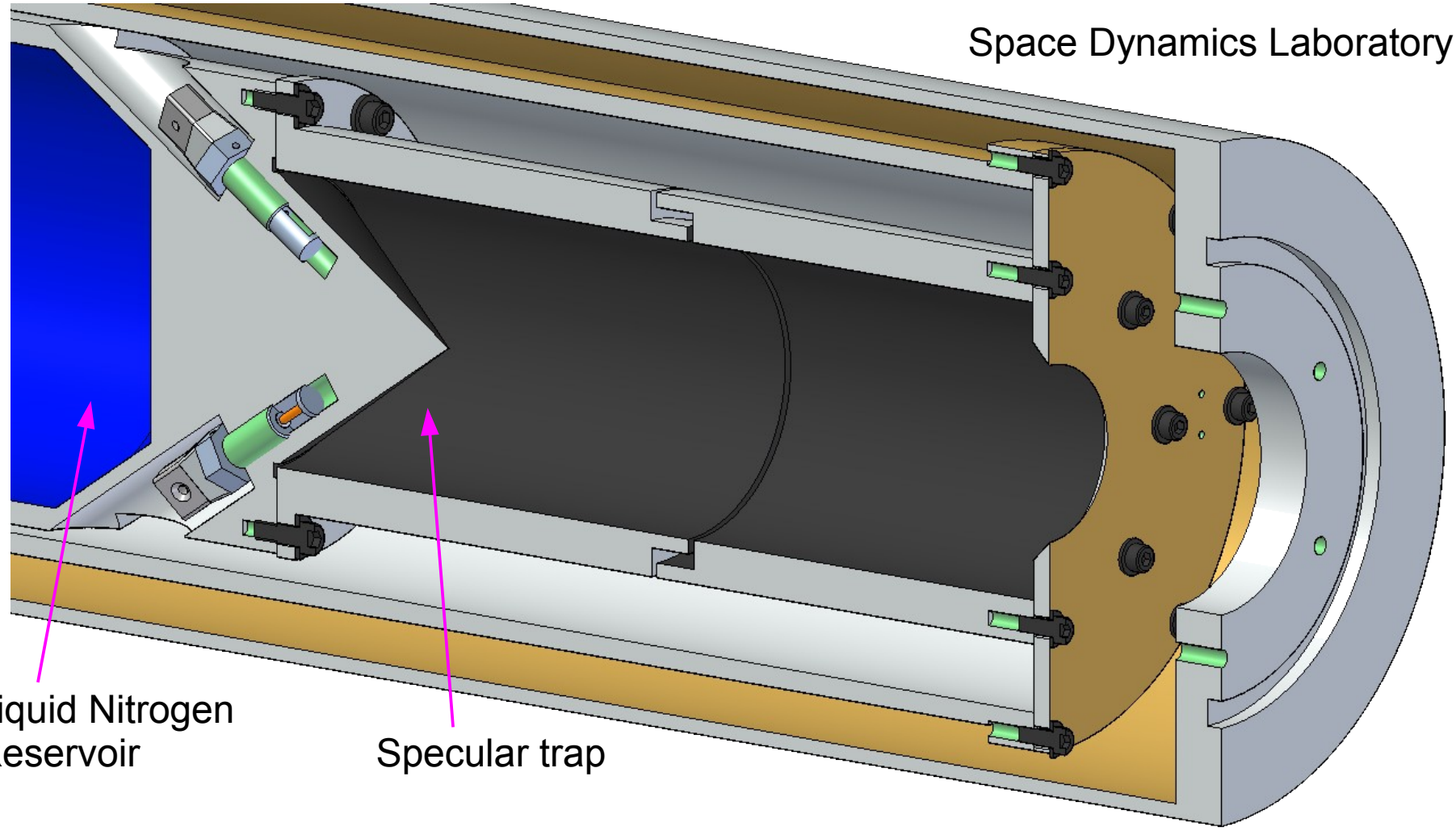


# Internal Reference Source



# Cold blackbody

Space Dynamics Laboratory

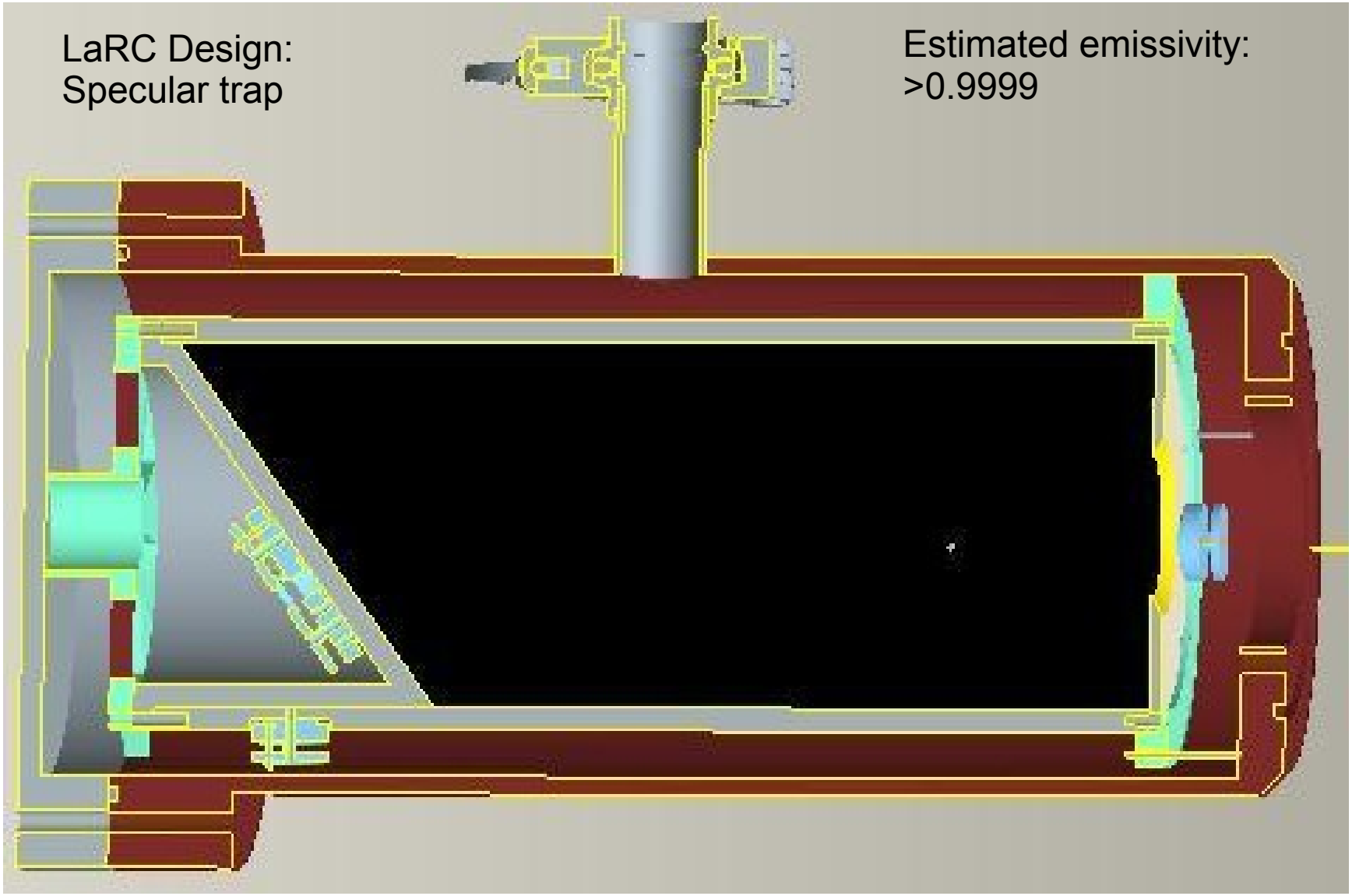



**Modeled emissivity is 0.9998 +/- 0.0002**

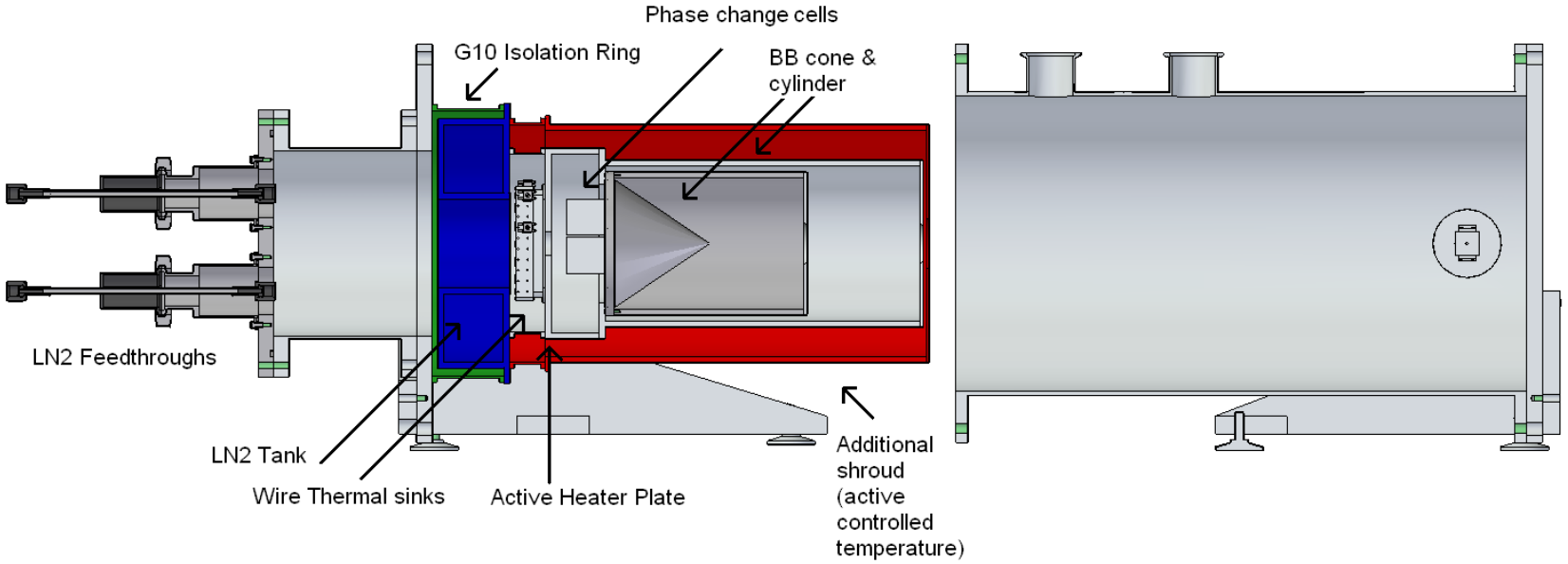
# Ambient blackbody

LaRC Design:
Specular trap

Estimated emissivity:
>0.9999



# Variable temperature blackbody

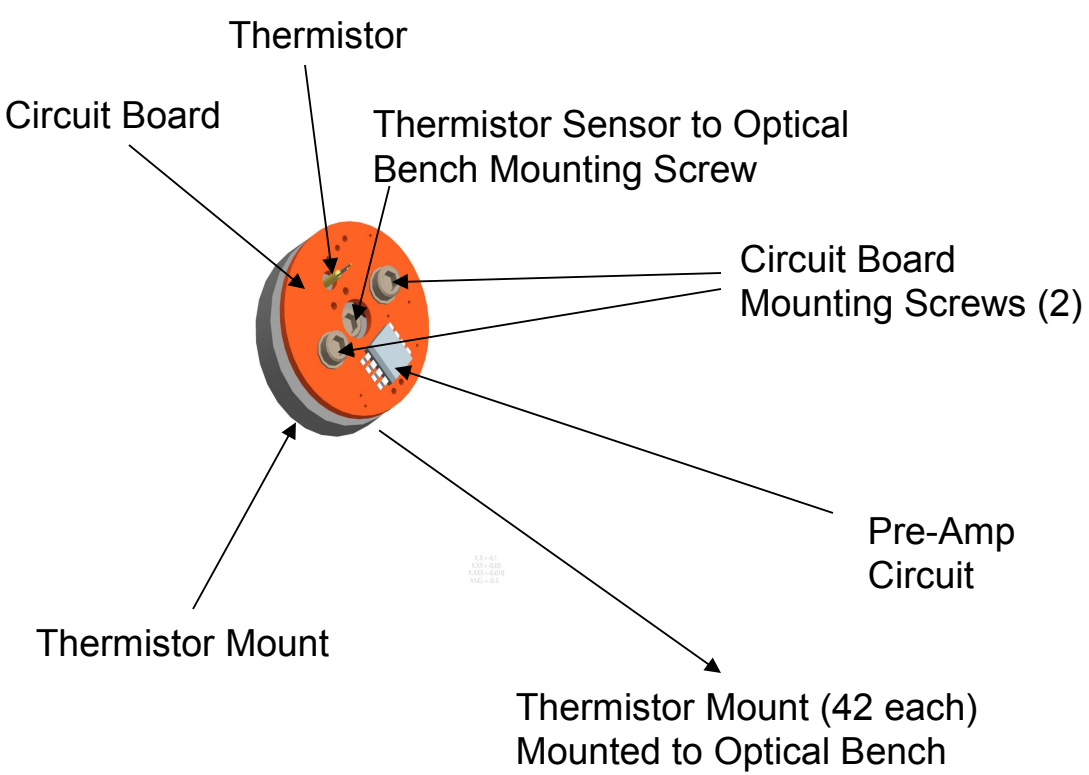


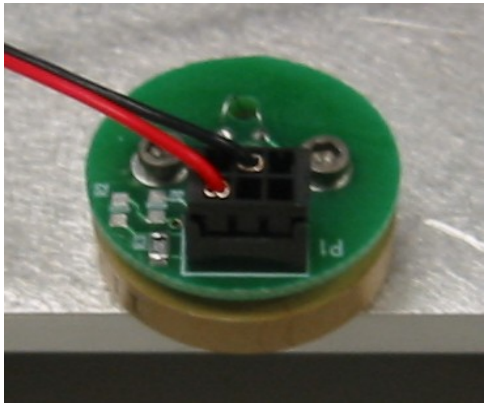

Developed by Space Dynamics Laboratory under CORSAIR IIP;
Estimated emissivity > 0.99988

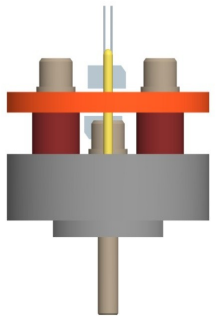

# Detectors

- Start with 4K bare silicon bolometer:
  - Single detector covers full band;
  - Fast detector with uniform response at expected modulation frequency;
  - Good SNR with short integration times.
- Eventually integrate pyroelectric detector:
  - Representative of flight detectors;
  - Less sensitive; long integration times required;
  - Test frequency compensation and averaging to reduce noise.
- Finally, add longwave and midwave MCT detectors
  - Also representative of flight detectors
  - Demonstrate reduction of nonlinearity errors by limiting bandwidth
  - Test nonlinearity correction.

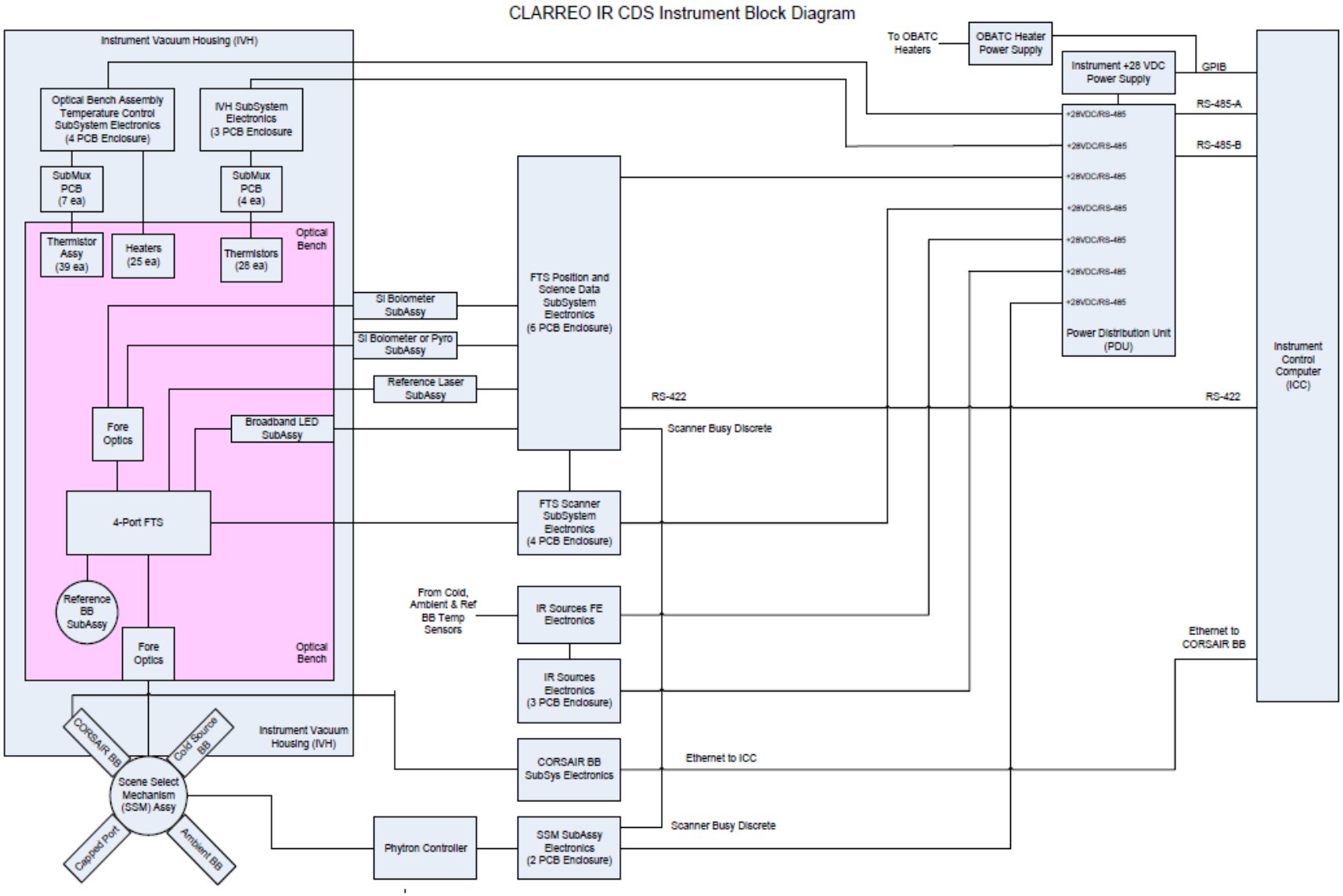
# Temperature Sensors





# Block diagram

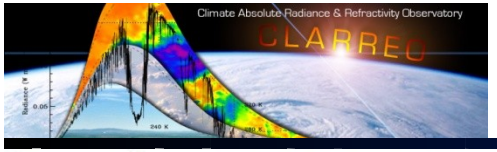


# Electronics subsystem example

## Science Detector Readout and FTS Position Electronics


**4” x 6” 6-board Stack**
**Housekeeping**
**DC-DC Converter**
**ZPD/ZXD Position Detector**
**FPGA, FTS Position Readout**
**Science Detector Front End**
**Scan Controller Interface**

**Science Channel ADC:**
**15.4 / 16 bits resolution**
**10kHz cut-off**
**Gain Deviation 0.05%**
**Constant phase resp. & group delay**




# Status

| Refer. # | CDS SubSystem Development |
|---|---|
| | CDS Project Milestones |
| | **Mechanical System** |
| M0-0 | Calibration Demonstration System |
| M0.5-0 | IR Instrument & Vacuum Housing Assembly |
| M1-0 | IR Instrument Assembly |
| M1-2 | FTS Reference Blackbody |
| M2-0 | Vacuum Chamber Assembly |
| M3-0 | CORSAIR Blackbody Assembly |
| M4-0 | Detector Dewar Assembly |
| M5-0 | Cold Source Blackbody Assembly |
| M6-0 | Ambient Blackbody Source Assembly |
| M7-0 | Assembly/ Install Platform |
| M8-0 | Air Table Layout |
| M9-0 | Door Slide Assembly |
| M10-0 | Scene Select Mechanism Assembly |
| M11-0 | Prototype Optical Bench Assembly |
| M12-0 | LaRC Reference Interferometer |
| | **Electrical System** |
| E1-0 | Instrument Control Computer (ICC) & Software |
| E2-0 | Power Distribution Unit (PDU) |
| E3-0 | Thermometry & Thermal Control |
| E3-4 | FTS Reference Blackbody Electronics |
| E4-0 | Science Detector Readout & FTS Position Electronics (SDR & FTS PE) |
| E5-0 | CIRS Scan Mechanism |
| E6-0 | Scene Select Mechanism (SSM) |
| E7-0 | Instrument Vacuum Housing |
| E8-0 | IR Sources Electronics |